BREEDING Improved HORTICULTURAL PLANTS

By A. F. Yeager

II. Fruits, Nuts, and Ornamental

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THE DEVELOPMENT OF A NEW VARIETY OF FRUIT and its introduction after it has been developed requires much more time than is necessary for vegetable plant breeding. This is because most of the plants must be grown several years before they come into bearing from seed. A greater growing space is also required for each fruit plant than for a vegetable plant. For these reasons, it is impossible to work with such large numbers as is done with vegetable crops This means slower progress with fruit and woody ornamental plant breeding.

The groundwork for a real plant-breeding program has now been laid at the University of New Hampshire. Breeding stock has been collected and has reached maturity. Some of the seedling populations are also nearing their bearing age. Therefore, more rapid progress may be expected within the next few years than has been possible during the past ten years.

This bulletin is the second in a series of two publications which was planned to tell you about some of the accomplishments of the plant-breeding program at the New Hampshire Agricultural Experiment Station. It outlines the work under way with fruits and ornamentals, indicates in what direction the work is aimed, and points out what results may be anticipated.

The first publication of the series, Station Bulletin 380, is concerned with vegetable plant breeding, and discusses the work with tomatoes, melons, squashes, peppers, peas, eggplant, popcorn, beans, cabbage, and carrots. It is called "Breeding Improved Horticultural Plants. I-Vegetables."

FRUITS, NUTS and ORNAMENTALS

FRUITS

New Hampshire Plant-breeding Program Experiments with

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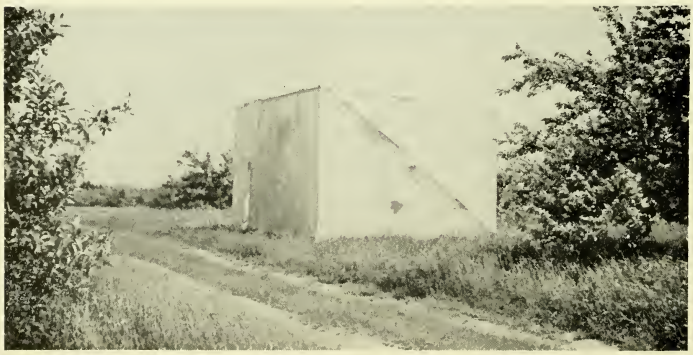
APPLES

Apple-breeding work at the University of New Hampshire has not as yet reached the pay-off stage. Its objectives are to provide a variety of as high quality as *McIntosh*, one that is productive, red in color, ripens later in the fall, and that will keep longer in the spring. The *Winter Banana* variety is the only variety that over the years, at Durham, N. H., has consistently outyielded *McIntosh*. It also has the most nearly perfect tree in shape and size. At Geneva, N. Y., *Winter Banana* gave a high percentage of good seedlings among the few which were grown. It was decided, therefore, to make crosses between this variety and *McIntosh*. Several hundred such seedlings are being grown, some of which are now reaching bearing age. Crosses have also been made between *Northern Spy* and *Macoun* with a similar objective in mind.

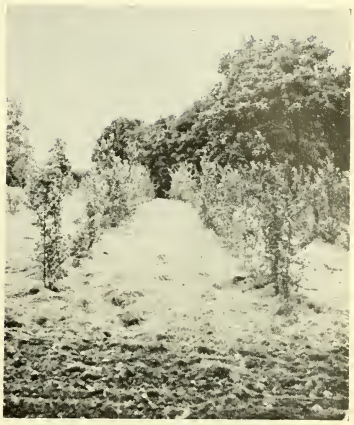
A tetraploid *McIntosh*, with double the normal number of chromosomes, was discovered by a United States Department of Agriculture worker in northern Massachusetts, in 1947. On this tree



Apple tree under an insect-proof cage for crossing.

crosses were made in the spring of 1948, using *Winter Banana* pollen. Abundant fruits were set and seed was produced. Where *Winter Banana* was used as the female and the pollen from the tetraploid *McIntosh* was used on *Winter Banana*, no fruits set.

Seedlings from this particular cross should give triploid trees which will be two-thirds *McIntosh*. Here we shall have an opportunity to observe a population of *McIntosh* and *Winter Banana*, using both diploid and tetraploid McIntosh as the female parent. The results may be valuable from a plant breeder's point of view and there may be equally interesting observations for geneticists. For instance, are these seedlings actually triploids? Miss Charlotte G. Nast, Assistant Professor of Botany, who is now engaged in determining this point from root tips that were collected before the trees were set in the field, finds that most of them are triploids. If they are triploids, it is possible we may get a variety which does not require cross pollination, as in the case with *Baldwin*, which is a triploid.



Seedling apples in breeding project.

PEACHES

Durham is on the northern border of the area where peaches can be grown. At the University of New

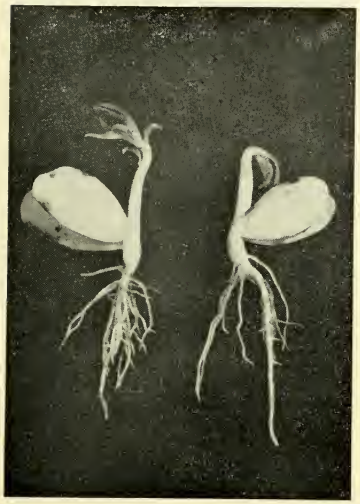
Crossing peaches.

A cross between the North Caucasus peach and Eclipse.

Hampshire Horticultural Farm the hardiest of ordinary varieties such as *Oriole, Cumberland,* and *Eclipse* will mature a satisfactory crop in about half the years. In other years, they produce little or nothing. One mile distant from the University Farm, at the village of Durham, peach blossom buds rarely live through the winter and a crop is an infrequent occurrence; hence, this locality is excellent for doing peach breeding work as it is necessary to detect the seedlings which have greater hardiness.

During the winter of 1943-44, reports were received that plant introductions from the North Caucasus region had proved unusually hardy at the United States Plant Introduction Station at Glenn Dale, Md. Immediate arrangements were made to have pollen from several of the North Caucasus seedlings sent by mail to Durham, when the trees bloomed in Maryland. The pollen from these seedlings was stored in a dessicator over calcium chloride under refrigeration, and was used on several of the hardiest peach varieties. Crosses were made with *Oriole, Eclipse, Cumberland,* and *Vedette.* These seeds were stratified, were planted indoors in the spring of 1945, and were set in the field when the weather permitted. They made a satisfactory growth in 1945 and 1946. In the spring of 1947, these crossed trees bloomed profusely and most of them set a good crop of peaches. A few backcrosses were also made with *Eclipse* and *Oriole.* Another heavy crop of fruit was produced in 1948. Thus, two crops were produced on trees within their first four years from seed. In 1948, several hundred seedlings of the F_2 generation produced trees that made a satisfactory growth. About two-thirds of them have been eliminated at the end of the first season's growth because, by that time, it was possible to determine by leaf-vein color that the fruit they were destined to bear would be white, an undesirable characteristic. Space was thus made in which more seedlings were planted in 1949. Observations made on

germinating peach seed in the spring of 1949 has shown that one need not wait until leaf maturity to determine the flesh color of the fruit a tree will bear. Before seedlings emerge from



Peach seedlings at this age have a yellow color if they will grow into a tree bearing yellow fruits.

the soil they will be white or yellow, corresponding to the flesh color of the fruit which they will some day produce. Seeds from pure white peach trees give only white seedlings, from pure yellow only yellow, and in F_2 populations when three white to one yellow are expected, such a ratio was found in the seedlings. The use of this information will permit the early discarding of undesirable white peaches and will greatly reduce the cost of doing peach-breeding work. Of course, there are some which are difficult to classify; hence, 100 per cent accuracy cannot be expected.

Genetic stocks of possible unusual hardiness now being grown include seedlings from the University of Minnesota, the *South Hero* peach from the Lake Champlain region, and also a few plants from several individuals who believe they have unusually hardy material. Under normal conditions, nature should help test them quickly.

PEARS

Little pear-breeding has been done in the New Hampshire Agricultural Experiment Station program. It has involved crosses between *Clapp's Favorite*, which is by far our most vigorous and productive variety, and *Conference*, a very good, high-quality winter pear. The objective is not only to produce a variety as productive, vigorous, and of as good quality as *Clapp's Favorite*, but also one which will ripen during the winter instead of in August, as does *Clapp's*. Some of these seedlings are nearing the bearing age. Blight is not a factor at Durham.

GRAPES

Earliness is a prime requisite in grapes. While *Concord* is reasonably hardy, it rarely develops good quality because the growing season is too short and cool. The best varieties in order of ripening are *Erie*, *Van Buren*, *Fredonia*, and *Kendaia*. In 1948, other varieties in our vineyard failed to bear. *Erie*, the earliest variety, does not produce pollen. For this reason fruits produced during the year were necessarily pollinated by the others noted Seed of *Erie* was saved and planted, resulting in 1,500 seedlings which have been set in the field. From them we hope to procure extra-early, hardy, high-quality varieties, capable of self-fertilization.

RASPBERRIES

DURHAM RASPBERRY

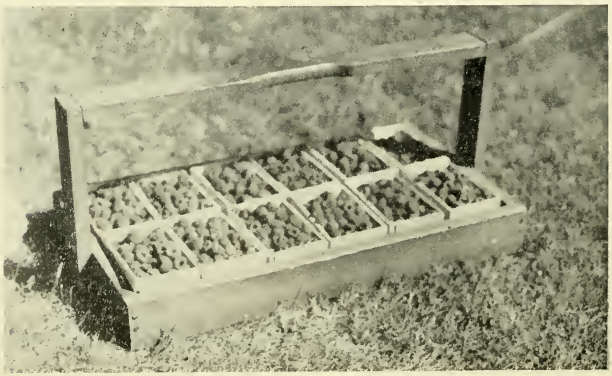
In the spring of 1942 in the University Greenhouse, blossoms of *Tay-*

lor raspberries were emasculated and pollen was supplied from *Nectarberry*, which was also grown indoors. Seeds were set, saved, and stratified. The seedlings were grown in the spring of 1943 and set in the field. Many of them bore some fruit in the spring of 1944. None showed evidence of *Nectarberry* parentage. Among the seedlings many produced an early fall crop. One of them, which later was named *Durham* probably grew from a parthenogenetic seed of *Taylor*. Fruit on this seedling began ripening on August 10 and continued to mature until the frost period. In the spring of 1945, suckers were taken from this plant and set in another row for further trial. Again, beginning about the middle of August, these transplants produced abundantly that same autumn. The original clump of plants likewise produced an abundant fall crop. In the spring of 1946, sucker plants again moved to a new location and increased. The newly set plants and the old plants made such a promising yield that it was decided to give the new variety the name *Durham* and to distribute it.

The berries of *Durham* are red, medium in size, of fair quality, and firm. Among the everbearing varieties and seedlings tested, *Durham* is the only one to date which has produced enough of a crop in the fall to promise profitable possibilities. The first blossoms are at the tip, but side branches appear progressively back from the tip so that the bearing area becomes very large. *Durham* reproduces by suckers which appear in abundance. The young plants, which grow four to five feet in height, seem as susceptible to spur blight as the parent, *Taylor*. Canes so affected winter kill, but those which are not affected appear to be as hardy as *Latham*. Annual crops may be expected, which is not always the case with varieties bearing only on overwintering canes. Spur blight, which to date has been controlled by the removal of all canes, may thus be avoided without the loss of a year's crop. *Durham* has been reported as producing well in Ontario, Iowa, North Dakota, and Oregon.

OTHER RUBUS BREEDING

Crosses have been made between *Taylor* raspberry and selections of



Durham Everbearing raspberry produces abundant early fall crops.

Rubus chamaemorus plant in fruit. This octoploid plant crossed with the diploid Taylor raspberry has given interesting results.

Rubus odoratus, the flowering raspberry. The seedlings from these crosses have been very weak growers, bear pink sterile flowers, and produce almost no sucker plants. Crosses between *Rubus odoratus* and *Snyder* blackberry have also been made. Seedlings from this cross have been almost sterile, although some seed on this hybrid was produced in 1948 and again in 1949. A few seedlings have been started. The blackberry cross is very vigorous, is thornless, and spreads rapidly by suckers.

The thornlessness and disease-resistance of *Rubus odoratus* are highly valuable features. It is hoped that they may be incorporated in good fruiting varieties.

Crosses were also made in the winter of 1942 and 1943 between *Taylor* raspberry, a diploid, and *Rubus chamaemorus*, the bake apple berry, an octoploid, which was obtained from R. B. Pike of Lubec, Maine. The bakeberry plant produces yellow fruits on plants less than six inches high. Hybrids between it and raspberry proved to be quite fertile, some bearing pinkish-yellow fruits, others red. These plants grew to about two feet in height. They were only half winter hardy.

Seed saved from these hybrids gave a second generation of seedlings, all of a suckering habit and varying from six inches to eight feet in height. Some are hardy, some are not. One of the best selections

These hybrid raspberries are produced on two foot plants.

grows about 30 inches high. It has branching canes and the fruit is a good red raspberry, ripening very early. Such plants would be easier to winter in difficult locations in the Northeast, as the snow covers them.

An F_3 generation is being grown and some of the promising F_2 selections are being increased for wider trial. It is evident already that from this cross good red raspberry varieties, ranging in plant height from six inches to six feet, can be developed. What their chromosomes numbers may be has not been determined; but as raspberry has 14 chromosomes and bakeberry 56, variation in numbers might be expected.

STRAWBERRIES

GREAT BAY STRAWBERRY

One of the principal objectives of the strawberry-breeding work has been to provide a variety that is later than *Howard No. 17* (Premier), our leading commercial variety. It might be equal or better than *Premier* in quality, productiveness, and resistance to disease. The cross between *Simcoe*, a very late, firm-fruited but rather acid variety from Canada, and *Catskill*, a handsome, dark-red, high-quality variety has given good seedlings. Rigorous testing in comparison with hundreds of other seedlings and the best named varieties, resulted in the selection of one which was named *Great Bay* in 1948. *Great Bay* is a vigorous-growing variety. It produces perfect flowers and the foliage is resistant to leaf spot. Fruit is produced in great abundance and begins ripening a few days after *Howard No. 17*. The plants also seem to have the ability to continue ripening their fruit over a long period, so that the last commercial pickings ripen with the last pickings of some varieties which produce their first ripe fruits very much later than *Great Bay*. Thus we get high productivity of late fruits plus the earlier crop, making the season's total much greater than varieties which produce no earlier crop.

OTHER STRAWBERRY BREEDING

Another strawberry population grown with the same objective in mind has come from crossing *Tupper*, a very late, large Canadian variety crossed with *Fairfax*. It has given some very good seedlings and the best of them possibly may be named.

Another objective of strawberry breeding at the New Hampshire Agricultural Experiment Station has been to introduce into the cultivated varieties some of the native wild strawberry's good characteristics, such as hardiness without winter mulching, high aroma, and desirable flavor. Selections made from the wild strawberry that seemed to have these desirable characteristics were studied under cultivation. They showed great variability, ranging from very soft to very hard fruits; from long, slender fruits to round; from very light color to dark; from very acid to sweet; and from plants which are extremely susceptible to leaf spot to those that seem to be almost entirely immune. First-generation crosses between selected wild strawberries and cultivated berries gave fruits of intermediate size on very vigorous productive plants and of acceptable fruit quality. They have also shown great ability to withstand unfavorable weather without damage. If any commercial varieties are to come from this group, however, it will be necessary to use the best of the first generation seedlings and back cross them again with high-quality, cultivated varieties to increase the size. This is being done.

A desirable wild low-bush blueberry used in crossing with cultivated high-bush varieties.

BLUEBERRIES

The high-bush blueberry *(Vaccinium corymbosum)* is native through the lower half of New Hampshire but the cultivated varieties of blueberries which belong to this species have not been too successful except in unusually good locations. In many winters, the part of the plant above the snow line is killed or severely injured by extreme weather conditions. The low-bush blueberry *(Vaccinium pennsylvanicum)* is found in great abundance over the sides of New Hampshire mountains. The low-bush blueberry, though no more hardy than the high-bush, escapes injury in severe winters because the plant is covered with snow. For this reason, breeding work with blueberries has been initiated with the idea of producing a commercially valuable half-high blueberry by crossing the low-bush and the high-bush. Such crosses occur naturally between unselected parents.

In the project carried on at the New Hampshire Agricultural Experiment Station, the best low-bush plants were selected and crossed with the best cultivated varieties of high-bush. The plants which resulted are intermediate in size, the fruits are much larger than the low-bush, but not as large as the cultivated high-bush. Some of the first generation plants, however, are very fruitful and may have value in themselves. One of the particularly good crosses has been a cross between a selection of low-bush blueberry from Gilford, N .H., and the *Pemberton* variety. A second generation of seedlings is being grown from this cross with the hope that we may get plants which will be about the size of the F_1 hybrid (*i.e.* about two feet high) that will produce fruits of large size and of bright blue color. Incidentally, this color is near black in the first generation seedlings, even though both parents are blue. It is also hoped that such a half-high bush, (like the low-bush plants,) may propagate by means of stolons. If this happens, the half-high will

A fruiting blueberry cross protected from birds.

become an easily-propagated cultivated variety more satisfactory to New Hampshire growing conditions, where a snow cover would prevent the plants from being winter injured.

The native high-bush blueberry reaches its northern limit in New Hampshire. Therefore, it is probable that selections made here would have greater winter hardiness than those made farther south. E. M. Meader has discovered two unusually good wild, high-bush blueberry plants; one at Loudon, N. H., designated *Sebatis*, and another called *Clarendon* No. 1 (P.I. 185436) at East Clarendon, Vt. These two plants have been crossed with several superior, unnamed cultivated blueberries developed by the United States Department of Agriculture at Weymouth, N. J. More than 2000 such hybrid plants have been grown. In this way we hope to produce hardier varieties which have the desirable fruit characteristics of the best cultivated sorts.

NUTS

BUTTERNUTS

In an effort made to locate the best butternut trees in the area, a prize was offered in 1940 for the finest sample of nuts sent to the New Hampshire Agricultural Experiment Station. Approximately 150 samples were received. Cracking tests were made on the samples, and from the lot, ten were chosen. The uncracked nuts from the samples were planted on the Station grounds. To date, none have fruited, although many have produced male catkins. Great variability has been noted between the different plots, particularly in regard to stature, vigor, and foliage characteristics. The leaves of one have not been affected by leaf disease which frequently defoliates ordinary butternuts. Upon checking with Harry Townsend of Lebanon, N. H., who provided these nuts, it was learned that the tree from which these nuts were taken was locally reputed to be a cross between *Butternut* and *Japanese Walnut*. This may be true, as these species are of the same genus and resemble each other in many superficial characteristics.

One of the most important results from such a breeding project comes from the fact that visitors who note what we are attempting to do send in specimens and information which they think may be valuable. This has been the case with butternuts. As a result of such a visit, a report has come from Frederickson, New Brunswick, of a local butternut tree which is more than 15 feet in circumference, breast high, and which produced nearly 20 bushels of nuts in 1948. Cracking tests made on a sample indicate that the nuts are of good cracking quality. This is by far the largest tree of this species

of which we have knowledge. Perhaps it, too, is resistant to the leaf disease which we feel may be largely responsible for winter killing of this species at frequent intervals and the generally unthrifty appearance of trees which have reached any considerable age.

HICKORY NUTS

Considerable scouting has been done by members of the University of New Hampshire Department of Horticulture in an attempt to locate extra good hickory trees. The best nuts collected have been planted and some trees are growing. However, hickory grows so slowly that it may be a long time before any tangible results are secured.

HAZEL AND HAZEL-FILBERT HYBRIDS

Among the nuts which may be grown in New Hampshire, the *corylus* genus probably offers greater possibilities for profitable production than any other. The *Winkler* variety of hazel, growing on the University of New Hampshire Horticultural Farm, fruits practically every year. It began bearing the year after it was set. In good seasons a bush five or six feet high may bear as many as two quarts of hulled nuts. The *Winkler* is well worth planting for home use, although the nuts are small compared to the European filberts.

Although many have been tried, no true filberts have been hardy enough to be worth growing. Besides *Winkler*, the *Rush Hazel* as well as varieties of the *Jones* and other filbert-hazel hybrids have been growing quite well. While they have not borne as consistently as the *Winkler*, they produce a crop in most years. The nuts are larger and ripen earlier than *Winkler*. Hazels are largely self-sterile, so it was thought that nuts collected from *Winkler* in the variety planting would probably be mostly pollinated by the hybrid varieties.

For this reason, a planting of 200 seedlings from *Winkler*, open pollinated, were set in 1946. Observations show that there is much variability among the seedlings and that a considerable portion have been crossed with the hazel filbert hybrids. A few seedlings produced nuts in 1948. During the winter of 1946-47, nearly all the blossoms on the *Jones* hybrids were killed. One plant, however, was outstanding in its productivity in 1947, as compared to other hybrids. These nuts were saved and planted with the expectation that *Winkler* probably had pollinated most of the blossoms. Nearly 300 seedlings are growing. It is quite probable that some plants in these two populations will produce larger nuts, and that they will be equally hardy, and will mature earlier. If this should come about, hazel-filbert hybrids might well be a common part of the future horticultural plantings in this region.

WOODY ORNAMENTALS

LILACS

Ann Tighe Lilac

The purple lilac is the State Flower of New Hampshire. The New Hampshire Federation of Garden Clubs has undertaken the accumulation of a fund for lilac research at the New Hampshire Agricultural Experiment Station. Naturally, the breeding of new varieties is undertaken as a part of this program. The first crosses were made in 1940 with double, dark-colored flowers of large size as the objectives. One of the seedlings of *Volcan*, the pollen parent unknown, was the outstanding plant of this group which flowered in 1945. It produces large clusters, and the semi-double florets are very large and almost as rich in color as *Volcan*. The first outstanding seedling, selected as a memorial to the late Mrs. Anne Tighe of Salmon Falls, N. H., because of her active support of lilac work, was given her name.

Other Lilac Breeding

A study of the important lilac varieties which are growing in the University Lilac Arboretum shows that really fine pink varieties are missing. Crosses were made in 1944 in an attempt to develop such a good pink. The most satisfactory pink variety in the planting was *Lucie Baltet*, and it was thought that perhaps if this variety were crossed with a white variety a reasonable proportion of pinks might result. Crosses were made between *Lucie Baltet* and *Madame Fernande Viger*, *Frau Bertha Damman*, *Jeanne de Arc*, and the common white lilac *(Vulgaris alba)*. More than 150 seedlings were produced from these crosses. Nearly all blossomed in 1948, but not one produced flowers of a desirable pink color. There were a few light blues, but nearly all ran from light purple to very dark purple. Therefore, it is evident that color in common lilacs is due to complimentary genes.

Some of the new Canadian varieties have come from crosses between the species *Syringa villosa* and *Syringa reflexa*. Some are quite satisfactory pinks, which, blooming much later than common lilacs, escape the spring frosts which often damage *Syringa vulgaris*. To try to get better late varieties, open-pollinated seeds from three varieties, *Hedin*, *Royalty*, and *Coral*, were planted. Nearly all the seedlings from these plants, which were started in 1945, blossomed in 1948. There was a wide range of color in the flowers and a wide range in the height and characteristics of the plants. All were late flowering. Four seedlings of *Royalty* parentage were marked as particularly desirable and propagated by soft wood cuttings for further observation.

Several attempts have also been made to try to cross *Syringa Japonica* the Asiatic tree lilac (which produces white flowers with a strong odor in large clusters very late in the season) and the common lilac. To date, only one seedling has been produced, and this may be a hybrid. This cross was made by Henry Clapp in 1944. Up to this time it has not flowered, but is making a very vigorous growth, and we hope that it may blossom before long. Should it prove to be a cross and fertile, we may have here the beginning of a new group of colored tree lilacs that bloom far later than anything of that kind we have had heretofore.

Crosses were attempted again in 1949, using *S. Japonica* as the female parent and *villosa x reflexa* seedlings as pollen. Seed pods developed in abundance but none contained seed.

HONEYSUCKLE

With the objective of producing a low-growing variety of honeysuckle with the attractive flowers of the *Tatarian* honeysuckle *(Lonicera tatarica)* and the blue edible fruit of the wild honeysuckle *(Lonicera caerulea)* crosses have been made between these two species. The first generation of plants have been spreading low-growing shrubs which reach four feet in height. The flowers are not too attractive and the fruits are red or orange in color. A second generation is now being grown from this hybrid but the results are yet to be determined.

FLOWERS

CHRYSANTHEMUMS

Granite State

Granite State was produced in an effort to develop better pot varieties of chrysanthemums for indoor culture. This variety is a second-generation seedling from the cross *Silver Sheen* and *White Doty* made by W. D. Holley. It was introduced in the florist trade in 1944 and has been featured by one of the largest wholesale florists in the country. *Granite State* is a naturally dwarf compact plant with snow-white, ball-shaped, hard, semi-incurred flowers. It blooms naturally in late October but responds well to shading to produce early bloom. It is very well adapted to pot culture.

Nashua

W. D. Holley also developed *Nashua*, one of a group of hardy chrysanthemums which not only are suitable for outdoor culture but also

A chrysanthemum blossom before and after preparation for crossing.

bloom early in the fall, and produce good-quality flowers on long stems suitable for cutting. It is a seedling of *Early Bronze*. The upright plant is about 24 inches in height and blooms early in September. The blossoms are bronze to deep red in color, depending upon the temperature at the time of blooming. They are of the pom-pom type and are useful for cutting as well as for border planting.

Sunapee

Sunapee has proved to be one of the most popular of Mr. Holley's introductions. It is a tall, upright plant which grows about 30 inches in height. It has golden pom-pom type flowers, a good stem, a fine cluster of blooms, and is excellent for cutting. The blooming time for *Nashua* is September 20 and later at Durham.

OTHER CHRYSANTHEMUM VARIETIES

Three other varieties of chrysanthemums, *Franconia*, *Laconia*, and *Exeter*, which are similar to *Nashua* and *Sunapee*, were named by Mr. Holley. *Franconia* and *Laconia* are tall enough for cutting, but *Exeter* is a dwarf.

DIANTHUS

June Carmine

This hardy outdoor variety came from a cross between *Dianthus plumarius* and the indoor carnation variety, *Rosalie*. It is a vigorous dianthus, 10 to 12 inches in height. Under good growing conditions, it will spread from two to three feet. Its double flowers are deep carmine pink in color and are produced profusely in late June and late July. There is some tendency to produce a second and lighter crop of flowers in September and October. No protection is required for an outdoor planting of this variety.

Granite State pot chrysanthemum, a new perfect potting variety.

BEGONIAS

New Hampshire Hybrid

This is a strain of *Begonia semperflorens*, developed by Mr. Holley during the process of studying inheritance in begonias. The strain produces dwarf, well-branched plants, with double or semi-double flowers and green foliage. Because such a high proportion of the plants are unusually good, it has not been propagated as separate clons by asexual means but is introduced as a seed-propagated strain. The blossoms come in red, shades of pink, and white.

Other Begonias

Crosses were also made between double semperflorens and a red leaf type. One of the seedlings from such breeding which has created considerable attention has red leaves and large, bright pink double flowers. While this variety has not been named, it has been propagated to a considerable extent by interested visitors to the University of New Hampshire greenhouse and undoubtedly may be found in many begonia collections in this region.